UNITED STATES DISTRICT COURT
DISTRICT OF NEW JERSEY

BATH & BODY WORKS BRAND MANAGEMENT, INC., Plaintiff, v. TRI-COASTAL DESIGN GROUP, INC. Defendant.	CIVIL ACTION Index No.: 2:12-cv-00957-WJM-MF
TRI-COASTAL DESIGN GROUP, INC. Counterclaim Plaintiff, v. BATH & BODY WORKS BRAND MANAGEMENT, INC., Counterclaim Defendant.	

DEFENDANT'S EXPERT REPORT FOR
CLAIM CONSTRUCTION HEARING

Served: August 10, 2012

By: Robert J. McHenry

Expert Report as of August 9, 2012
Robert J McHenry
BBW v Tri-coastal Design

I have examined the functionality of the bottle features described in the '415 patent and those of the bottle features described in the '532 patent. To supplement my analysis, I have carried out measurements and physical experiments on bottles purchased from a BBW retail store. These purchased bottles correspond well to the figures contained in the patents in question.

The '415 patent

With respect to the '415 patent, I have concluded that the "hourglass shape" and the "side flutes" operate separately and jointly to make the bottle less likely to slip from the consumer's hand. In reaching this conclusion, I have relied on physical examination and measurement of bottles that I purchased from a BBW retail outlet and on data and studies from the scientific literature. These features would provide significant functional advantages with any packaged product but are particularly valuable for a shower or bath gel because the consumer's hand will be partially covered with the product or a mixture of the product and water making the bottle more slippery.

Appendix A to this report contains the detailed calculations supporting my conclusion. In summary, for a bottle without the hourglass feature, the consumer would have to squeeze the bottle with an appreciable normal force sufficient to generate a vertical frictional force equal to or greater than the gravitational force acting on the bottle. For a bottle with an hourglass shape, a smaller grasping force is required because the bottle would have to push the fingers apart in order to move downwardly. Thus, for an hourglass shape, there are two forces opposing downward movement, friction and mechanical interference. My calculations show that the hourglass shape will reduce the grasping force required by 27% when the outside surface of the bottle is dry and by 57% when the surface is covered by a soapy material.

The hourglass shape will not be effective or as effective if the bottle should rotate about its vertical axis in such a way that the consumer's fingers are exerting their force on the flat faces of the bottle rather than on the hourglass sides. Although most consumers would presumably be aware of the advantage of grasping the bottle by the sides, there are forces that would tend to rotate the bottle away from this preferred orientation. These forces would include gravitational forces when the bottle is not held completely vertical (e.g. during pouring), acceleration forces when the bottle is being moved, and impact forces when the bottle touches the shower wall or the consumer's body. Without the ridges on the sides of the body, the only force opposing the rotation would be friction between the fingers and the bottle surface. With the ridges on the side of the bottle, however, there is an additional resistance due to mechanical interference. This is a well known phenomenon and has resulted in ridges being added to many objects to improve graspability. See, for example, the lead paragraph in the following article from the scientific literature.

Human finger contact with small, triangular ridged surfaces S.E. Tomlinsona, M.J. Carréa,∗, R. Lewisa, S.E Franklinb

[a] The Department of Mechanical Engineering, The University of Sheffield, UK
[b] Philips Applied Technologies, Eindhoven, The Netherlands and University of Sheffield, UK

1.

Introduction

Ridges are often added to surfaces to improve grip of objects such as; sports equipment, kitchen utensils, assistive technology, aids, etc. Although considerable work has been carried out to study skin friction, there is very little work in the literature to suggest how these ridged patterns affect friction or how any effects can be modelled (for an overview see for example [1,2]). A survey as part of a previous study [3] examined a wide range of textures found on 69 typical handheld objects including, amongst other things, food packaging and household utensils. Texture designs fell into four main categories; criss-cross patterns, dimples, pimples and ridges. The most common category was a ridge pattern, either triangular or rectangular in cross-section and between 0.1 to 5.0 mm in height. This paper is concerned with fine surface textures that have trian- gular ridges at the small end of this spectrum, ranging from 0.003 to 0.26 mm in height.

Based on this article and on some simple experiments that I conducted myself, I have concluded that the resistance to rotation with flutes will be over 58% higher than that provided by friction alone when the bottle is dry and more than that when the bottle is soapy.

With respect to the rounded top and bottom shoulders shown in figures 2, 3, 4 and 5, they would provide improved mechanical performance both directly because of the structural behavior of round structures and because they would result in more uniform material distribution in the blow molding process. Round structures are well known to provide improved resistance to compressive and bending loads compared to structures having sharp corners. This is why, throughout history, there have been so many domed buildings and why deep sea research vessels are spherical. Such compressive and bending loads are generated on most bottles during the capping process and on bottle used for pump dispensing because of the vertical force applied by the consumer during pumping.

In either an injection blow molding process, such as most commonly used in forming PET bottles, or an extrusion blow molding process, such as most commonly used with polyethylene or polypropylene, the process starts with a perform that is much thicker and of a smaller diameter than the final bottle. The thickness of the plastic becomes gradually thinner as it approaches the bottle mold. With sharp corners at the top and bottom corners of a bottle, the plastic would become unacceptably thin. Such thin corners would result in reduced mechanical properties and even rupture if the bottle is dropped. The rounded corners avoid this problem.

Figure 7 of the ‘415 patent probably implies a form of concave bottom. This is not clear because the side views in figures 2 through 5 do not include any hidden lines that would

show such concavity. Commercial BBW bottles do have such a concave bottom. Such concave bottoms are very common in blown bottles because they improve stability; i.e., they don't wobble. With an injection blow molded bottle (or with the reheat-blow variation of conventional injection blow molding), there is often a sprue that protrudes from the bottom of the preform. A sprue is a remnant of the location where the plastic entered the injection mold. The sprue present in the preform will also often be present in the bottle and, if the bottom of the bottle is not concave, the bottle will not rest flatly on the counter and will wobble. In fact, BBW's trapezoidal/parallelogram bottles have sprues and recessed bottoms although none are apparent in figure 8 of the '532 patent. Extrusion blow molded bottles also normally have concave bottoms because of the excess material present at the pinch-off.

Another functional advantage of a concave bottom is that it provides a protected place for markings and labels. A marking identifying the type of plastic is required in this country to facilitate sorting in a recycle center. The marking for a PET bottle is a 1 enclosed in a triangle and the letters PETE beneath the triangle. A concave bottom is also a good place to put a paper label showing the UPC and/or the price with the label protected from becoming abraded as a result of sliding on a shelf or of shipping vibrations.

In summary, I have concluded that each of the design features shown in the '415 patent the;

hourglass shape,
ridged sidewalls,
rounded corners and
concave bottom,

is functional rather than being purely ornamental.

The '532 patent

With respect to the '532 patent, I conclude that the main trapezoidal shape when viewed from the sides, the parallelogram cross section when viewed from above or below, the shorter trapezoid immediately below the cap, and the bottom trapezoid all provide significant functional advantages.

The main trapezoidal shape feature provides improved vertical stability or resistance to tipping over when the bottle is subjected to a horizontal force in a plane above the base. Such a horizontal force component can easily occur with bottles having a pump dispenser such as BBW's various hand soaps. If the consumer does not exert the pumping action in an exactly vertical direction, there will be a horizontal force component in addition to the desired vertical force component. The trapezoidal shaped bottle will have a significantly lower center of gravity. The "critical tipping point" for a container occurs when the bottle is gradually tipped until the center of gravity is vertically above the side of the base about which the rotation is occurring. I have determined by experiment that the critical tipping point for BBW's 8 fluid ounce anti-bacterial hand soap, which corresponds generally to

the ‘532 patent, is 29 degrees from vertical when rotated above its longer side base whereas the critical tipping point for their 8 fluid ounce cylindrical “fine fragrance mist” bottle is only 14 degrees. The critical tipping point for BWW’s 28 ounce bacterial soap, which also corresponds generally to the ‘532 patent, is 21 degrees.

In addition to this vertical stability advantage of the trapezoidal shape, there is a hand positional advantage. The trapezoidal shape allows the consumer to position her hand directly under the end of the dispensing spout, preventing the soap from dripping onto the counter or the side of the bottle. This dripping will not be an issue with every application of the soap because sometimes the product will be projected far enough from the bottle to reach a hand that is more distant from the side of the bottle. It will, however, often occur at the beginning and end of the flow, particularly if the bottle hasn’t been used for a while.

While it should be possible to avoid this problem with a longer spout to the pump, this would be more costly and could cause problems with the positioning of bottles on a store shelf.

The parallelogram shown on the patent drawing has a 115 degree angle at two corners of the cross section of the bottle and a 65 degree angle at the other two corners; whereas, a rectangular cross section parallelogram has ninety degree angles at all four corners.. For a pump dispensing bottle, the functional advantage of the non-ninety degree angle is with respect to a combination of hand position and vertical stability. As can be seen in figure 7 of the ‘532 patent, it is possible to position one’s hand very close to the outer diameter of the cap at the top of the bottle. It should be noted that it would also be possible to position one’s hand at the same proximity to the cap with a sufficiently elongated rectangular cross section of the same area. With such a narrow rectangle, however, the bottle would be easier to tip over because the lateral distance between the center of gravity and the centermost bottom edge is smaller than the corresponding distance for the non-perpendicular parallelogram.

The above argument of the functionality of the parallelogram cross section is with respect to a pump container. There is also a functional advantage of this cross section for a bottle in which the product is dispensed by gently squeezing the bottle. In this case, one could utilize a rectangle of a less elongated shape because it is not critical to position one’s hand close to the cap. Such a less elongated rectangular shape would be more resistant o tipping, but would be more difficult to squeeze in a controlled fashion. Not only would there be less of a elongated surface to easily deflect in order to expel the product but the right angle between the rectangle’s short side and its long side would resist the deflection more than the obtuse angle shown in the upper left and lower right corners of the bottle as shown in figure 7 of the patent.

With respect to the smaller trapezoid located directly below the cap, there are three functional advantages compared to a flat top. One advantage is that it provides greater vertical crush resistance through providing a transitional path for the loads from a pumping force exerted on the cap to the bottle sidewall. With a flat top rather than a trapezoid, the loads would be concentrated in the center of the flat top, creating high

bending loads in the top. With the trapezoid, the loads are spread out to the edges of the sidewall.

This trapezoid has a further advantage, as with the main trapezoid, of allowing the consumer to position her hands closer to the tip of the spout. Because the angle of this trapezoid is greater in the longer dimensions, this advantage will be greater when the spout happens to be in a rotational position above the longer diagonal of the parallelogram/

The third functional advantage of this trapezoid is that in lowering the corner of the main trapezoid, it will reduce the thinning that would otherwise occur in the corners along the long diagonal of the parallelogram.

With respect to the short inverted trapezoid near the bottom of the bottle (and the blending curve connecting this trapezoid to the main trapezoid), it acts much as the bottom shoulders of '415 in avoiding excessive thinning in the corners. It is even more important with this bottle because of the distance that the plastic travels from the preform to the corners at the long diagonal of the parallelogram.

Summary of conclusions on the functionality of the chief design features of the two design patents in question.

There are four distinguishing features of the bottle design shown in the '415 patent. The hourglass shape, as seen from the front of the bottle and the vertical ridges along the side of the bottle, separately and in combination, function to make the bottle less likely to slip from the consumer's hand. While this would be an important with any product contents, it is particularly important for a shower gel or other soapy product when the consumer's hands and the bottle would be covered by a low friction liquid. The rounded shoulders at the top and bottom of the bottle provide improved mechanical performance to the bottle; both because of the structural advantages of round structures and because they avoid thin corners from forming during the blowing of the bottle. The concave bottom of the bottle allows the bottle to sit on a counter without wobbling and provides a sheltered place for markings and labels.

There are four distinguishing features to the bottle shown in the '532 patent. The main trapezoidal shape as viewed from the front or side of the bottle and the parallelogram cross section of the bottle as seen from the top or bottom separately and in combination, make the bottle less likely to tip over when the pump is activated and enable the consumer to position her hand directly under the spout to avoid spilling of the product onto the counter or the surface of the bottle. If the product is to be dispensed from the bottle by squeezing rather than pumping, the parallelogram cross section would result in easier and better controlled squeezing. The improved vertical stability would still be a critical functional improvement even on a non-pump bottle. Although the bottle would probably be tipped over less frequently than in pumping, the result of a spill would be more serious in that there would sometimes be no cap on the container when it tipped over, resulting in a bigger spill.

The top trapezoid provides improves mechanical performance both by transitioning vertical loads from the cap to the sidewalls and by avoiding overly thin corners from forming during the blowing of the bottle. This trapezoid has a further advantage, as with the main trapezoid, of allowing the consumer to position her hands closer to the tip of the spout.

The bottom inverted trapezoid provides improved mechanical properties both in transitioning loads from the countertop into the sidewall and in avoiding excessive thinning during the blowing of the bottle.

Dated: August 9, 2012

/s/ Robert J. McHenry______
Robert J. McHenry

Appendix A
Resistance to Slippage (dropping) of a bottle with an hourglass feature

In the absence of an hourglass or other mechanical interference feature, the consumer must exert a normal force on the surface of the bottle sufficient to generate a friction force sufficient to overcome the gravitation force acting on the bottle. In reference article 1, from an international scientific journal, the authors provide some data on the coefficient of friction between living human skin and various materials. While the data vary with the part of the body on which the skin resides and with the nature of the second material, the experiments conducted are reasonably close to our conditions. In particular, the paper gives an average value of 0.47 for the friction between the palm of the hand and nylon. The paper reports that the coefficient for the palm of the hand is higher than for the other parts of the body studied. One would expect the coefficient of friction between the hand and a nylon object and that between the hand and a polyester bottle such as BBW bottles would be similar since the two polymers are similar in mechanical properties. The handbook value given for the coefficient of friction of polyester is slightly higher than that given for nylon, indicating that using the nylon value would be expected to be slightly conservative.

Using this value and the weight of the 10 fluid ounce BBW shower gel bottle, we can calculate that, in the absence of the hour glass feature, the consumer would have to exert a force of 1.6 pounds. to resist the 12.2 ounce weight of the filled bottle.

12.2 oz/0.47 = 26.0 oz or 1.6 pounds of force.

The article further references another paper that found that the coefficient "dropped by at least 75% when the surfaces were covered with soap." This would reduce the coefficient of friction to 0.1175. Using that coefficient in the previous equation gives us a value of 6.5 pounds for a soapy bottle.

With an hourglass shaped bottle, there would be an additional force component opposing the force of gravity. That force component would depend on the angle that the reduced waist makes with the vertical plane. In figures 2 and 3 from the '415 patent, the angle is shown as approximately 5 degrees. (With the actual BBW bottles, the angle is approximately 7.7 degree, providing somewhat more resistance to slippage.) Using the 5 degree value and letting X equal the required normal force; we have, for the dry bottle, the following equation.

Gravitational force = friction force + interference force
12.2 oz = X x 0.47 + X x tangent of 5 degrees
12.2 oz = 0.47 X x 0.158 X
Solving for X, we have X = 19 ounces or 1.214 lb, a reduction of 27% compared to the non-hourglass bottle.

For the soapy bottle, the required force to resist gravity would

12.2 oz =X x 0.1175 + X x .0.158,

X = 44.3 oz or 2.77 pounds, a reduction of 57% compared to the soapy non-hourglass bottle.

As described in the body of the report, these functional advantages of the hourglass shape would be lost if the bottle rotated to the extent that the consumer's fingers were no longer grasping the side of the bottle but rather the flat front and back surfaces. The ridges on the side of the body will aid in preventing this rotation. The extent to which these ridges will aid in preventing the rotation will depend on the depth of these ridges. Although the shading in figure 1 of the patent indicates that the ridges are fairly deep, there is no view that actually teaches the depth. Accordingly, I have sectioned the ridges on an actual BBW shower gel bottle that is purported to be representative of the design in the '415. Based on examination of this sectioned side wall, I estimate that the amplitude of the ridges is approximately 0.15 mm and the width of each ridge is approximately 0.35 mm.

This is within the range studied and reported on in reference 2 on "Human finger contact with small, triangular ridged surfaces", the introductory paragraph of which was quoted near the beginning of this report. In fact, two sets of the histogram presented in figure 7 of this paper bracket our conditions.

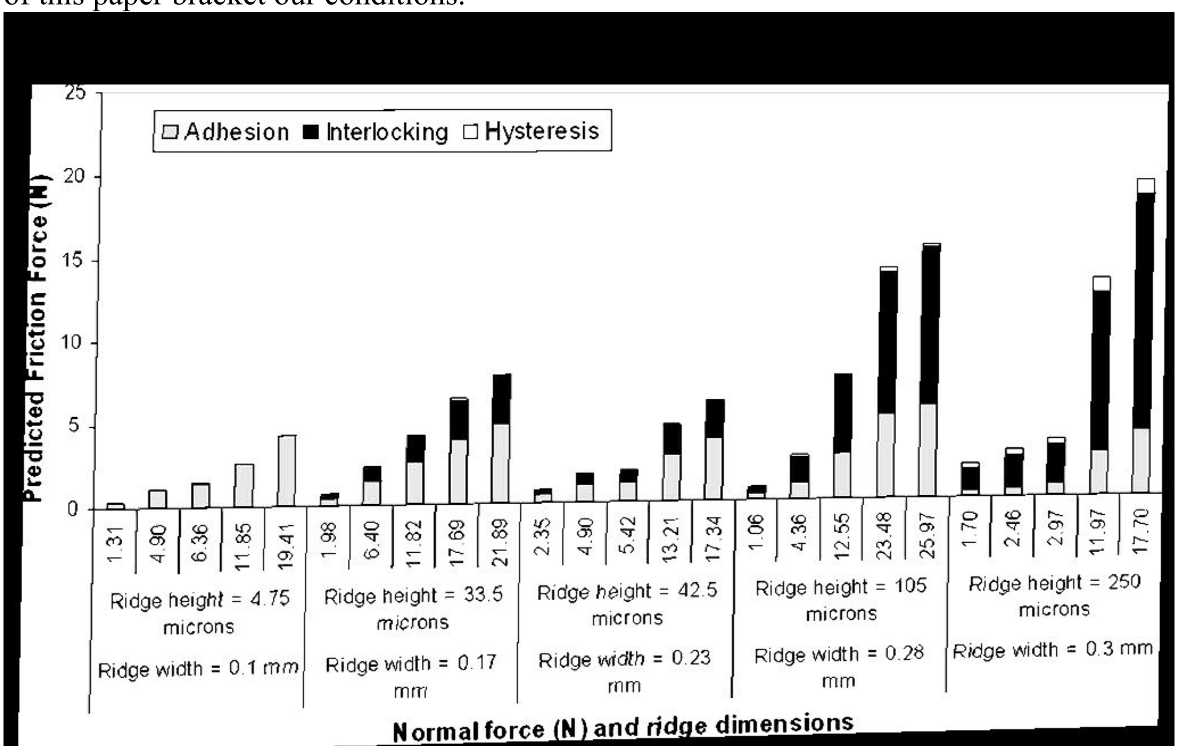

Figure 7

Because of the lack of clear designation on the dimensions of the ridges in '415, I also conducted a simple experiment to determine the effect of the ridges on the resistance to movement in the direction perpendicular to the direction of the side ridges. In this experiment, a BBW shower gel bottle was mounted on a slidable platform with the ridged side of the bottle above and parallel to the slidable platform. The ridges were perpendicular to the direction of movement. A hand was positioned above with the

fingers touching the ridges and a weight, in the form of another filled shower gel bottle, was placed in a position to push the fingers against the ridges of the lower bottle. The force required to slide the platform with the ridged bottle out from under the hand was then measured.

The following table combines the data from figure 7 of the paper with the estimated dimensions and conditions of the shower gel bottle in real use and the results of the above experiment.

	Histogram 4	Real use conditions	Slidable platform test	Histogram 5
Ridge height	0.105 mm	0.150 mm	0.150 mm	0.250 mm
Ridge width	0.280 mm	0.350 mm	0.350 mm	0.300 mm
Normal force Newtons	4.36	5.4 dry; 12 soapy	3.4 dry	12
% increase in resistive force	150%	Unknown	58%	360%

While the percent increase in resistance to rotation provided by the ridges is not exactly known, it is my conclusion from the above table that it is very significant and that their function is not just ornamental.

Ref 1 **Prosthetics and Orthotics International**, 1999, 23, 135-141

In vivo friction properties of human skin M. ZHANG and A. F. T. MAK

Ref 2 **Wear** (Volume 271, Issues 9–10, 29 July 2011, Pages 2346–2353
18th International Conference on Wear of Materials
Human finger contact with small, triangular ridged surfaces
S.E. Tomlinson, M.J. Carré, , , R. Lewis, S.E Franklin

Appendix B

Robert J. McHenry

Formal Education

B Chem Eng, Catholic University	1956
MS Chem Eng, University of Southern California	1957
Additional Graduate Studies, University of Southern California	1957-1959

Work Experience

1959-1962	Research Chemist (1st Lt); Polymer Branch, Air Force Material Laboratory
1962-1966	Chief; Chemical Processes Branch, Air Force Material Laboratory\
1966- 1969	Manager; Plastics Research, AVCO Space Systems Division
1969- 1972	Manager; Plastics Sciences, American Can Company
1972- 1976	Director; Plastics Technology, American Can Company
1976- 1984	Managing Director; Rigid Plastic Containers, American National Can
1984- 1988	Vice President: Plastic Containers, American National Can
1988- 1999	Vice President; Advanced Technology, American National Can
!999- present	President; Robert J. McHenry Inc, Technical Consultant

From 1959 through 1988, my work centered almost exclusively on plastics and, from 1969 – 1988, in particular, on rigid plastic containers. After that period, my work branched out to include other forms of rigid packaging, including metal cans and metal/plastic composite packaging.

Although all of the 37 patents (see attached list) issued in my name as inventor or co-inventor are utility patents, I am familiar with other forms of intellectual property from several years in which I served as the head of the Patent Committee for American National Can.

US Patents issued with Robert J. McHenry as Inventor or Co-inventor

	PAT. NO.		Title
1	6,626,314	T	Resealable closure for beverage container
2	6,332,767	T	Apparatus for injection molding multi-layer articles
3	6,220,470	T	Resealable closure for open end of container
4	6,194,041	T	Methods and apparatus for injection molding and injection blow molding multi-layer articles, and the articles made thereby
5	6,129,960	T	Methods and apparatus for injection molding and injection blow molding multi-layer plastic and the articles made thereby
6	6,098,829	T	Can components having a metal-plastic-metal structure
7	6,095,785	T	Apparatus for injection moulding multi-layer articles
8	5,975,871	T	Methods and apparatus for injection molding and injection blow molding multi-layer articles, and the articles made thereby
9	5,968,558	T	Apparatus for injection molding and injection blow molding multi-layer articles
10	5,862,939	T	Fabrication process for metal-polyester construction
11	5,853,772	T	Methods and apparatus for injection molding and injection blow molding multi-layer articles, and the articles made thereby
12	5,827,555	T	Foaming insert for a beverage container
13	5,782,375	T	Drawn and ironed cans of a metal-plastic construction and their fabrication process
14	5,770,290	T	Easy open end of a metal-plastic construction
15	5,523,045	T	Methods for injection molding and blow-molding multi-layer plastic articles
16	5,037,285	T	Apparatus for injection molding and injection blow molding multi-layer articles
17	4,946,365	T	Apparatus for injection molding and injection blow molding multi-layer articles
18	4,934,915	T	Apparatus for injection molding multi-layer articles
19	4,931,246	T	Method for injection molding multi-layer articles
20	4,925,100	T	Methods and apparatus for injection molding and injection blow molding multi-layer articles, and articles made thereby
21	4,895,504	T	Apparatus for injection molding and injection blow molding multi-layer articles
22	4,892,699	T	Methods for injection molding and injection blow molding multi-layer articles
23	4,880,129	T	Method of obtaining acceptable configuration of a plastic container after thermal food sterilization process
24	4,751,035	T	Plastic containers with folded-over internal layers and methods for

making same

25 4,745,013 **T** Multi-layer molded articles

26 4,712,990 **T** Apparatus for injection molding and injection blow molding multi-layer articles

27 4,667,454 **T** Method of obtaining acceptable configuration of a plastic container after thermal food sterilization process

28 4,642,968 **T** Method of obtaining acceptable configuration of a plastic container after thermal food sterilization process

29 4,568,261 **T** Apparatus for making a multi-layer injection blow molded container

30 4,554,190 **T** Plastic containers with folded-over internal layers and methods for making same

31 4,526,821 **T** Multi-layer container and method of making same

32 4,525,134 **T** Apparatus for making a multi-layer injection blow molded container

33 4,044,086 **T** Method for making a blow molded oriented plastic bottle

34 3,984,498 **T** Blown thermoplastic bottle and method for making same

35 3,949,038 **T** Blown thermoplastic bottle and method for making same

36 3,934,743 **T** Blow molded, oriented plastic bottle and method for making same

37 3,657,190 **T** Method for forming pyrrone molding powders and products of said method

Technical Papers and Publications

1. A study of the burning rate of Bickford Fuse under constant pressure, temperature, and volume conditions NAVORD report 4279. June 1956
2. Figure flash equilibrium easier, quicker this way. Petroleum Refiner March 1958
3. Mechanism of thermal degradation of polymers, part I, aspects of degradation. J Poly Sci vol 58 (1962)
4. Copolymerization of nonconjugated di olefins: General Compositional relationships. J Poly Sci vol 2 1961
5. "Review of state-of-the-art of solid rocket case fabrication techniques. Interagency Solid Rocket Case Propulsion Meeting, Seatle 1963
6. Antenna windows for hypersonic and reentry vehicles. Ninth Electromagnetic Windows Symposium, Atlanta Georgia June 1968
7. Three-dimensionally fiber reinforced reinforced graphite composites. A. I. ChE Materials Conference (April 1968)
8. Packaging multiconference report, Part II: Multilayer structures. PM&E March 1987
9. Plastic Cans: out of the lab, into the stores. Plastics World, Feb 1986